



Atty. Dkt. No. 040356-0574

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Appellant: Masatoshi IIO
Title: ANODE EFFLUENT CONTROL IN FUEL
CELL POWER PLANT
Appl. No.: 10/554,317
International Filing Date: 4/9/2004
371(c) Date: 10/24/2005
Examiner: Tony Sheng Hsiang Chuo
Art Unit: 1795
Confirmation Number: 4554

BRIEF ON APPEAL

Mail Stop Appeal Brief - Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Under the provisions of 37 C.F.R. § 41.37, this Appeal Brief is being filed together with a credit card payment form in the amount of \$540.00 covering the 37 C.F.R. 41.20(b)(2) appeal fee. If this fee is deemed to be insufficient, authorization is hereby given to charge any deficiency (or credit any balance) to the undersigned deposit account 19-0741.

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REAL PARTY IN INTEREST

The real party in interest is NISSAN MOTOR CO., LTD.

RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board's decision in the present appeal.

STATUS OF CLAIMS

1. Claims pending: 25-49.
2. Claims cancelled: 1-24.
3. Claims withdrawn: None.
4. Claims rejected: 25-49.
5. Claims on appeal: 25-49.

A copy of claims 25-49 is provided in the CLAIMS APPENDIX.

STATUS OF AMENDMENTS

Claims 1-24 were initially pending in the application filed on October 24, 2005. Claims 1-24 were cancelled and claims 25-49 were added as new claims in the preliminary amendment filed on October 24, 2005. Claim 46 was amended to correct a typographical error in the Amendment and Reply filed February 26, 2010. An Advisory Action mailed March 16, 2010, stated that the after-final amendment would be entered. Appeal of claims 25-49 is appropriate because all of the claims have been twice rejected.

SUMMARY OF CLAIMED SUBJECT MATTER

Claims 25, 37 and 49 are independent claims.

Independent claim 25 is directed to an anode effluent control method for a fuel cell power plant. At least Fig. 1 and pp. 5-6 of the application discloses a fuel cell stack which performs power generation using anode gas having hydrogen as a main component, the anode gas being discharged from the fuel cell stack as anode effluent following a power generation reaction, a return passage which re-circulates the anode effluent into the anode gas, and a purge valve which discharges the anode effluent in the return passage to the outside of the passage. At least Figs. 4-7 and pp. 12-13 of the application discloses calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed. At least Figs. 4 and 7, and pp. 12-13 of the application discloses calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened. At least Figs. 3 and 4, and pp. 13-14 of the application discloses maintaining the purge valve in a closed state when the second energy loss is larger than the first energy loss. At least Figs. 3 and 4, and pp. 13-14 of the application discloses opening the purge valve when the second energy loss equals or falls below the first energy loss.

Independent claim 37 is directed to an anode effluent control device for a fuel cell stack. At least Fig. 1 and pp. 5-6 of the application discloses that the fuel cell stack performs power generation using anode gas having hydrogen as a main component, the anode gas being discharged from the fuel cell stack as anode effluent following a power generation reaction. At least Fig. 1 and p. 6 of the application discloses a return passage which re-circulates the anode effluent into the anode gas. At least Fig. 1 and p. 6 of the application discloses a purge valve which discharges the anode effluent in the return passage to the outside of the passage. At least Fig. 1 and p. 6 of the application discloses a programmable controller. At least Figs. 4-7 and pp. 12-13 of the application discloses a programmable controller programmed to calculate a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed. At least Figs. 4 and 7, and pp. 12-13 of the application discloses a programmable controller programmed to calculate a second energy loss which

corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened. At least Figs. 3 and 4, and pp. 13-14 of the application discloses a programmable controller programmed to maintain the purge valve in a closed state when the second energy loss is larger than the first energy loss. At least Figs. 3 and 4, and pp. 13-14 of the application discloses a programmable controller programmed to open the purge valve when the second energy loss equals or falls below the first energy loss.

Independent claim 49 is directed to an anode effluent control device for a fuel cell stack. At least Fig. 1 and pp. 5-6 of the application discloses that the fuel cell stack performs power generation using anode gas having hydrogen as a main component, the anode gas being discharged from the fuel cell stack as anode effluent following a power generation reaction. At least Fig. 1 and p. 6 of the application discloses a return passage which re-circulates the anode effluent into the anode gas. At least Fig. 1 and p. 6 of the application discloses a purge valve which discharges the anode effluent in the return passage to the outside of the passage.

Claim 49 contains means-plus-function language permitted under 35 U.S.C. § 112, sixth paragraph. The structure corresponding to the claimed “means for calculating a first energy loss” and “means for calculating a second energy loss” is shown at least in Fig. 1 and described on pages 5-8 and includes at least the fuel cell stack 1, temperature sensor 10 and the controller 11. Further, at least Figs. 4-7 and pp. 12-13 of the application discloses means for calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed, and at least Figs. 4 and 7, and pp. 12-13 of the application discloses means for calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened.

The structure corresponding to the claimed “means for maintaining the purge valve” and “means for opening the purge valve” is shown at least in Fig. 1 and described on pages 5-8, and includes at least the fuel cell stack 1, temperature sensor 10, the controller 11, and control valves 6 and 8. Further, at least Figs. 3 and 4, and pp. 13-14 of the application discloses means for maintaining the purge valve in a closed state when the second energy loss is larger than the first energy loss, and at least Figs. 3 and 4, and pp. 13-14 of the application

discloses means for opening the purge valve when the second energy loss equals or falls below the first energy loss.

GROUND OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection to be reviewed on appeal are:

Whether the examiner erred in:

Finally rejecting claims 25-49 under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement.

ARGUMENT

I. The rejection of claims 25-49 under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement

Claims 25-49 were finally rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. The Final Office Action asserts that “[t]he information present in the current application, as originally filed, does not teach exactly how to make and use the claimed invention.” *See* Final Office Action dated November 30, 2009 at p. 6.

Specifically, the Examiner asserts that it is “unclear how the hydrogen partial pressure, P_{H_2n} , is calculated because the water vapor pressure, P_{WSn} , is unknown since there is no explanation of how a qualitative value for the water vapor partial pressure P_{WSn} is obtained using the graph of Figure 5 which also has no units.” *See* Final Office Action dated November 30, 2009 at p. 3. In addition, the Examiner asserts that “one skilled in the art would not be enabled to calculate the first energy loss and the second energy loss without additional guidance on how to determine the maps shown in Figures 6 and 7. *See* Final Office Action dated November 30, 2009 at p. 6. Further, the Examiner asserted that “[w]ithout knowing the specifics on how to generate the maps shown in Fig. 6 and 7, one skilled in the art would require a considerable amount of experimentation that is not routine in the art.” *See* Final Office Action dated November 30, 2009 at pp. 6-7.

The enablement requirement requires the specification to describe the invention “in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same.” 35 U.S.C. § 112 (2006). As explained in MPEP § 2164.01, “even though the statute does not use the term ‘undue experimentation,’ it has been interpreted to require that the claimed invention be enabled so that any person skilled in the art can make and use the invention without undue experimentation.” MPEP § 2164.01 (citing *In re Wands*, 858 F.2d at 737, 8 U.S.P.Q.2d at 1404 (Fed. Cir. 1988)). “The test of enablement is not whether any experimentation is necessary, but whether, if experimentation is necessary, it is undue.” MPEP § 2164.01 (citing *In re Angstadt*, 537 F.2d 498, 504, 190 U.S.P.Q. 214, 219 (CCPA 1976)). That determination

is made from the viewpoint of persons experienced in the field of the invention, *Elan Pharm., Inc. v. Mayo Found.*, 346 F.3d 1051, 68 U.S.P.Q.2d 1373 (Fed. Cir. 2003), and “requires the application of a standard of reasonableness, having due regard for the nature of the invention and the state of the art.” *In re Wands*, 858 F.2d 731, 737, 8 U.S.P.Q.2d 1400 (Fed. Cir. 1988).

The factors to be considered when determining whether there is sufficient evidence to support a determination that a disclosure does not satisfy the enablement requirement and whether any necessary experimentation is "undue" includes but are not limited to: (A) The breadth of the claims; (B) The nature of the invention; (C) The state of the prior art; (D) The level of one of ordinary skill; (E) The level of predictability in the art; (F) The amount of direction provided by the inventor; (G) The existence of working examples; and (H) The quantity of experimentation needed to make or use the invention based on the content of the disclosure. *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988) (reversing the PTO's determination that claims directed to methods for detection of hepatitis B surface antigens did not satisfy the enablement requirement).

In view of the legal context set forth above and the reasons set forth below, Appellant respectfully submits that the specification provides sufficient guidance under 35 U.S.C. § 112 to allow one of skill in the art to practice the claimed invention without undue experimentation. Thus, the enablement rejection of claims 25-49 is improper and should be withdrawn.

A. One of ordinary skill in the art could obtain or generate the maps shown in Figs. 5-7 without undue experimentation.

1. Fig. 5

The Examiner asserts that it is “unclear how the hydrogen partial pressure, PH_{2n} , is calculated because the water vapor pressure, PWS_n , is unknown since there is no explanation of how a qualitative value for the water vapor partial pressure PWS_n is obtained using the graph of Figure 5 which also has no units.” See Final Office Action dated November 30, 2009 at p. 3.

Based on the amendment to the specification made in the Amendment and Reply filed February 24, 2010, PWSn denotes a water vapor partial pressure of the anode gas. The specification discloses on page 11 that “the controller 11 refers to a map having the characteristic shown in Fig. 5, which is stored in the internal memory (ROM) in advance to determine a water vapor partial pressure PWSn of the cathode gas from the temperature TCSAn of the fuel cell stack 1.” Appellant submits that one of ordinary skill in the art would know how to “determine a water vapor partial pressure PWSn of the cathode gas from the temperature TCSAn of the fuel cell stack” without undue experimentation.

For example, PWSn is determined from a saturated water vapor pressure which is dependent on a temperature of the fuel cell. Saturated water vapor pressure can be estimated from the temperature of the fuel cell using procedures known to those of ordinary skill in the art. For example, in the fuel cell art at the time of the invention, it was known that, when a fuel cell is operative, there is an inverted water diffusion from the cathode side to the anode side. The moisture resulting from this inverted water diffusion saturates the anode gas passage with water vapor, except in the vicinity of the inlet of the anode gas passage. As a result, condensed water is apt to be generated downstream in the anode gas passage.

Accordingly, one of ordinary skill in the art would approximate that the water vapor partial pressure in the anode gas to be substantially equal to a saturated water vapor pressure, which can be estimated from the temperature of the fuel cell. Appellant submits that the teaching of processing condensed water generated in the anode gas passage is shown in other references, such as Japanese Published Patent Applications JP2008-134620A and JP2007-214062, for example.

Further, where the electrolyte membrane creates a relatively small inverted water diffusion and where an anode effluent discharged from the anode gas passage outlet of a fuel cell stack is recirculated into the anode gas passage inlet as shown in FIGS. 1 and 8, gas components other than water vapor in the anode gas effluent take a minimum value at the anode gas passage outlet. In a stable state operation, the anode gas is saturated with water vapor. As a result, the water vapor partial pressure is substantially equal to the saturated water vapor pressure, which can be estimated from the temperature of the fuel cell.

In sum, the information presented in FIG. 5 can be derived based on the assumption that the water vapor partial pressure PWSn in the anode gas is substantially equivalent to the saturated water vapor pressure, which is known to be determined dependent solely on the temperature. Further, the saturated water vapor pressure is not affected by the conditions of the fuel cell stack other than the temperature.

Appellant submits that it is known by one skilled in the art at the time of the invention that the saturated vapor pressure is dependent on the temperature of the fuel cell. Further, one of ordinary skill in the fuel cell art would know and understand that under stable operating conditions, the saturated vapor pressure is substantially equal to the water vapor partial pressure PWSn in the anode gas. A patent need not teach, and preferably omits, what is well known in the art. *In re Buchner*, 929 F.2d 660, 661, 18 USPQ2d 1331, 1332 (Fed. Cir. 1991); *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1384, 231 USPQ 81, 94 (Fed. Cir. 1986), *cert. denied*, 480 U.S. 947 (1987); and *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 1463, 221 USPQ 481, 489 (Fed. Cir. 1984). Accordingly, based on the determination of saturated vapor pressure, one of ordinary skill in the art could determine the water vapor partial pressure PWSn of the anode gas without undue experimentation.

The Advisory Action states that “there is no evidence to support the argument that the water vapor partial pressure PWSn in the anode gas is substantially equivalent to the saturated water vapor.” However, Appellant notes that the conclusory statement that there is no evidence to support “the argument that the water vapor partial pressure PWSn in the anode gas is substantially equivalent to the saturated water vapor” is not sufficient to support a rejection under 35 U.S.C. § 112, first paragraph. MPEP § 2164.04 states “it is incumbent upon the Patent Office, whenever a rejection on this basis is made, to explain *why* it doubts the truth or accuracy of any statement in a supporting disclosure and to back up assertions of its own with acceptable evidence or reasoning which is inconsistent with the contested statement.” No such support or evidence has been presented by the Examiner. Further, the Advisory Action ignores the teachings of Japanese Published Patent Applications JP2008-134620A and JP2007-214062 which describe processing condensed water generated in the anode gas passage.

2. *Fig. 6*

Appellant respectfully submits that the map of Figure 6 can be easily generated using equations (1)-(4) discussed in the specification with the fuel cell stack illustrated in Figure 1. The hydrogen partial pressure PH_{2n} is calculated using equation (4).

$$(4) \quad PH_{2n} = (\text{anode gas pressure}) - (PN_n + PWS_n)$$

Equation (4) includes the overall permeated nitrogen gas amount of the fuel cell stack parameter which is calculated from equations (1) and (2) and includes known values such as the membrane area, membrane thickness and gas permeation coefficient of the electrolyte member of the fuel cell stack, the nitrogen partial pressure of the cathode gas parameter which is substantially constant when the fuel cell stack is operated in a steady state, and the nitrogen partial pressure of the anode gas parameter which is calculated to increase over time.

Equation (4) also includes parameters such as the passage volume and normal pressure of the fuel cell stack which have known values; the temperature TCS_{An} of the fuel cell stack detected by a temperature sensor; and the water vapor partial pressure PWS_n determined from the temperature TCS_{An} . Values for these variables are calculated from a time t_0 to t_n , for example.

Further, one of ordinary skill in the art would understand that the generated energy EDH_{2n} , of the fuel cell is equivalent to the output energy of the fuel cell stack and hence this value can be measured/approximated based on the output energy of the fuel cell stack. For example, the generated energy EDH_{2n} could be measured in a state where no purging is performed. The hydrogen partial pressure PH_{2n} of the anode gas at the time of this measurement can be calculated from the measurement conditions. By plotting the pairs of EDH_{2n} and PH_{2n} , which show time-dependent variations, on a graph, a usable map corresponding to Figure 6 can easily be obtained by one of ordinary skill in the art.

Regarding the Examiners comments concerning units in Figs. 5-7, any units can be assigned to these parameters as long as the units have a fixed relation to standard units. For example, the generated energy can be expressed in joules (J) since the variable EDH_{2n} represents energy. Likewise, the hydrogen partial pressure can be expressed in newton per

square meter (N/m^2) since the variable PH_{2n} represents pressure. Furthermore, one of ordinary skill in the art would know what units are used to specify measurements such as temperature, pressure and energy.

Concerning the Examiner's assertion that there is no explanation of what variables are measured, what mathematical formula or equation is used to calculate the generated energy EDH_{2n} , the fuel cell operating conditions that were used to generate the map, or the hydrogen partial pressure PH_{2n} shown in Figure 6, Appellant respectfully submits that the hydrogen partial pressure PH_{2n} is calculated using equation (4) as discussed above. When the fuel cell stack is operated in a steady state, the anode gas pressure of equation (4) is a constant known value. The nitrogen partial pressure PN_n of equation (4) is calculated based on equation (3) with each of the variables of equation (3) described in the application as filed. Also as discussed above, a value for the water vapor partial pressure PWS_n of equation (4) can be obtained using the graph of Figure 5, whereby the curve of the graph represents the comparison of the temperature of the fuel stack TCS_n , (plotted on the abscissa), with the water vapor partial pressure PWS_n (plotted on the ordinance). Initially, the pressure remains constant as the temperature increases. Afterwards the pressure linearly increases as the temperature increases.

Accordingly, Appellant submits that one of ordinary skill in the art could have obtained the information depicted in Fig. 6 without undue experimentation.

3. *Fig. 7*

The Examiner asserts that there is no explanation for the calculation of the second energy loss based on the map shown in Figure 7. In response, Appellant respectfully submits that the hydrogen energy EDP_n is based on the purging interval of the fuel cell. A preferred purging point A (defined during the time period between t_0 and t_n) shown in Figure 3, provides that the sum of energy loss due to not purging and the energy loss due to purging takes a minimum value (specification, page 8, lines 12-14). A qualitative value for the variation in the hydrogen energy ΔEDP_n can be obtained whereby the curve of the graph of Figure 7 represents the comparison of the elapsed time since purging (plotted on the abscissa), with the variation in the hydrogen energy ΔEDP_n (plotted on the ordinance).

Initially, the variation in the hydrogen energy ΔEDP_n decreases as the elapsed time increases. Afterwards, the variation in the hydrogen energy ΔEDP_n remains constant as the elapsed time increases. Thus, the map of Figure 7 can be easily obtained by measuring the generated energy in a state where purging is performed. Accordingly, Appellant submits that one of ordinary skill in the art could have obtained the information depicted in Fig. 7 without undue experimentation.

B. The Examiner has not met the initial burden under 35 U.S.C. § 112, first paragraph of providing a reasonable basis to question enablement.

The Examiner has the initial burden to establish a reasonable basis to question the enablement provided for the claimed invention. *In re Wright*, 999 F.2d 1557, 1562, 27 USPQ2d 1510, 1513 (Fed. Cir. 1993). A conclusion of lack of enablement means that, based on the evidence regarding the *Wands* factors, the specification, at the time the application was filed, would not have taught one skilled in the art how to make and/or use the full scope of the claimed invention without undue experimentation. *See In re Wright*, 999 F.2d 1557, 1562, 27 USPQ2d 1510, 1513 (Fed. Cir. 1993).

Here, the Examiner's asserts that the specification does not teach one of ordinary skill in the art how to generate the maps shown in Figs. 5-7 without undue experimentation but fails to provide sufficient factors, reasons or evidence to support this assertion.

In the Final Office Action dated November 30, 2009 at pp. 6-7 the examiner admits that "[o]ne skilled in the art at the time of the application would have known a method of removing impurity gases by purging the gas in the anode recirculation passage in accordance with a decrease in hydrogen concentration of the anode gas, an increase in the impurity gases concentration of the anode gas, or a decrease in the output of the fuel cell system." Further, the Examiner admits that "[t]he relative skill in the art would have included using sensors to determine the hydrogen gas concentration, impurity gases concentration, temperature, and pressure of the anode gas."

In view of these admissions, the Examiner asserts that "one skilled in the art would not be able to make and use the claimed invention without undue

experimentation...[and]...[w]ithout knowing the specifics on how to generate the maps shown in Figures 6 and 7, one skilled in the art would require a considerable amount of experimentation that is not routine in the art.” See Office Action dated May 11, 2009 at page 4. However, the Examiner fails to present factors, reasons or evidence why one of ordinary skill in the art **could determine** “the hydrogen gas concentration, impurity gases concentration, temperature, and pressure of the anode gas” **but would not be able to determine** the value of water vapor partial pressure of the anode gas, energy generated by the fuel cell, hydrogen partial pressure, and the change in hydrogen energy lost through purging represented in Figs. 5-7 without undue experimentation.

The amount of guidance or direction needed to enable the invention is inversely related to the amount of knowledge in the state of the art as well as the predictability in the art. *In re Fisher*, 427 F.2d 833, 839, 166 USPQ 18, 24 (CCPA 1970). The "amount of guidance or direction" refers to that information in the application, as originally filed, that teaches exactly how to make or use the invention. The more that is known in the prior art about the nature of the invention, how to make, and how to use the invention, and the more predictable the art is, the less information needs to be explicitly stated in the specification.

Fuel cells are well-established technology. See U.S. Patent No. 3,959,019 filed June 11, 1975. Further, it can be reasonably concluded that it is also well-known in the art to use a controller which stores predetermined threshold values used to compare the detected value of the sensors with the stored threshold values as discussed in U.S. Patent No. 6,242,120, issued June 5, 2001. Accordingly, Appellant submits that the information at issue (specifically Figs. 5-7) does not need to be explicitly described in the specification.

Even though explicit description is not required, Appellant asserts that the as-filed specification provides full disclosure for one of ordinary skill in the art to generate the maps of Figures 5-7. In particular, the specification discloses an anode effluent control method for a fuel cell power plant including calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed and calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened. These calculations are based on the maps of Figures 6 and 7,

respectively. While Appellant concedes that each of the maps of Figures 5-7 specifies the relationship between two parameters qualitatively and not quantitatively, one of ordinary skill in the art can generate a map through routine experimentation if provided with qualitative or relational information (e.g., the shape of a curve) between two parameters as shown in Figures 5-7.

For example, one of skill in the art can generate an approximation formula such as $y = Ax^2 + Bx + C$ from a shape of a curve showing a qualitative relation between two parameters x , y . By obtaining a couple of experimental results (x_i , y_i), one can determine the coefficients A , B , C . Such an approximation process is well known in the art.

The as-filed specification on page 9, line 12 through page 12, line 1 clearly provides equations (1)-(4) which are used to calculate values for some of the parameters compared on the maps. Figures 5-7 include curves (i.e., known linear and exponential curves) representing the comparison of these parameters and showing a qualitative relationship between these parameters. One of ordinary skill in the art would know how to determine unknown parameter by performing simple experiments using the fuel cell stack illustrated in Figure 1. Thus, a skilled artisan would be able to generate the maps of Figures 5-7 with ease given this information.

The fact that some experimentation may be necessary to make or use the invention does not render the specification non-enabling. It is well established that “an extended period of experimentation may not be undue if the skilled artisan is provided sufficient direction or guidance.” *In re Colianni*, 561 F.2d 220, 224, 195 USPQ 150, 153 (CCPA 1977). Moreover, it has been argued that “...a considerable amount of experimentation is permissible, if it is merely routine, or if the specification in question provides a reasonable amount of guidance with respect to the direction in which the experimentation should proceed.” *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed Cir. 1988).

Appellant asserts that the present specification has provided a reasonable amount of guidance on how to generate the maps of Figures 5-7 and that the generation of maps such as these are not only well-known, but routine, to one of skill in the art. MPEP § 2164.04 states “it is incumbent upon the Patent Office, whenever a rejection on this basis is made, to explain

why it doubts the truth or accuracy of any statement in a supporting disclosure and to back up assertions of its own with acceptable evidence or reasoning which is inconsistent with the contested statement.” No such support or evidence has been presented by the Examiner. That is, the Examiner has not presented any factors, reasons or evidence why the maps generated in Figs. 5-7 could not be generated by one of ordinary skill in the art without undue experimentation. Thus, the enablement rejection of claims 25-49 is improper, and should be withdrawn.

CONCLUSION

In view of the foregoing, it is respectfully submitted that the rejections of record should be reversed.

Respectfully submitted,

Date _____

By Michael D. Kaminski

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5490
Facsimile: (202) 672-5399

Michael D. Kaminski
Attorney for Appellant
Registration No. 32,904

CLAIMS APPENDIX

25. An anode effluent control method for a fuel cell power plant comprising a fuel cell stack which performs power generation using anode gas having hydrogen as a main component, the anode gas being discharged from the fuel cell stack as anode effluent following a power generation reaction, a return passage which re-circulates the anode effluent into the anode gas, and a purge valve which discharges the anode effluent in the return passage to the outside of the passage, the control method comprising:

calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed;

calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened;

maintaining the purge valve in a closed state when the second energy loss is larger than the first energy loss; and

opening the purge valve when the second energy loss equals or falls below the first energy loss.

26. The anode effluent control method as defined in Claim 25, wherein the non-hydrogen component includes nitrogen and water vapor.

27. The anode effluent control method as defined in Claim 26, wherein the control method further comprises:

calculating a nitrogen partial pressure of the anode gas in accordance with a duration of the closed state of the purge valve;

determining a temperature of the fuel cell stack;

calculating a water vapor partial pressure of the anode gas on the basis of the temperature of the fuel cell stack;

calculating a hydrogen partial pressure of the anode gas by subtracting the nitrogen partial pressure and the water vapor partial pressure from an anode gas pressure; and

calculating the first energy loss on the basis of variation in the hydrogen partial pressure.

28. The anode effluent control method as defined in Claim 27, wherein the fuel cell stack comprises an anode which is exposed to the anode gas, a cathode, and an electrolyte membrane disposed between the anode and the cathode, the fuel cell power plant further comprises an air supply device which supplies air to the cathode, and the control method further comprises calculating the nitrogen partial pressure of the anode gas on the basis of an amount of nitrogen in the anode gas which increases as nitrogen in the air permeates the electrolyte membrane from the cathode so as to reach the anode.

29. The anode effluent control method as defined in Claim 27, wherein the fuel cell power plant further comprises an anode gas passage which supplies the anode gas to the fuel cell stack, a hydrogen supply device which supplies hydrogen to the anode gas passage, a catalyst which oxidizes carbon monoxide in the anode effluent in the return passage, and an air supply device which supplies air for oxidizing the carbon monoxide to the return passage, and the control method further comprises calculating an accumulated amount of the carbon monoxide in the anode gas that was contained in the hydrogen supplied to the anode gas passage from the hydrogen supply device, comparing the accumulated amount to a predetermined value, and supplying air to the return passage from the air supply device when the accumulated amount is larger than the predetermined value.

30. The anode effluent control method as defined in Claim 29, wherein the control method further comprises preventing the air supply device from supplying air to the return passage when the purge valve is open.

31. The anode effluent control method as defined in Claim 29, wherein the fuel cell power plant further comprises a pump for pressurizing the anode effluent in the return passage so as to introduce the anode effluent into the anode gas passage, and the control method further comprises reducing the rotation speed of the pump when air is supplied to the return passage from the air supply device.

32. The anode effluent control method as defined in Claim 29, wherein the control method further comprises calculating a partial pressure of carbon dioxide that is mixed into the anode gas as a result of a carbon monoxide oxidation operation performed by the catalyst, correcting the nitrogen partial pressure of the anode gas on the basis of an amount of air supplied to the return passage, and calculating the hydrogen partial pressure by subtracting the water vapor partial pressure, the carbon dioxide partial pressure, and a corrected nitrogen partial pressure from the anode gas pressure.

33. The anode effluent control method as defined in Claim 29, wherein the fuel cell power plant further comprises a recording device which pre-records a carbon monoxide content of the hydrogen that is supplied by the hydrogen supply device, and the control method further comprises calculating the accumulated amount of carbon monoxide in the anode gas on the basis of the carbon monoxide content recorded in the recording device.

34. The anode effluent control method as defined in Claim 27, wherein the control method further comprises calculating the nitrogen partial pressure of the anode gas as a value which increases as a duration of the closed state of the purge valve lengthens.

35. The anode effluent control method as defined in Claim 27, wherein the control method further comprises calculating the water vapor partial pressure of the anode gas as a value which increases as a temperature of the fuel cell stack rises.

36. The anode effluent control method as defined in Claim 25, wherein the control method further comprises calculating the second energy loss as a value which decreases in accordance with a duration of the closed state of the purge valve.

37. An anode effluent control device for a fuel cell stack which performs power generation using anode gas having hydrogen as a main component, the anode gas being discharged from the fuel cell stack as anode effluent following a power generation reaction, the device comprising:

a return passage which re-circulates the anode effluent into the anode gas;

a purge valve which discharges the anode effluent in the return passage to the outside of the passage; and

a programmable controller programmed to:

calculate a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed;

calculate a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened;

maintain the purge valve in a closed state when the second energy loss is larger than the first energy loss; and

open the purge valve when the second energy loss equals or falls below the first energy loss.

38. The anode effluent control device as defined in Claim 37, wherein the non-hydrogen component includes nitrogen and water vapor.

39. The anode effluent control device as defined in Claim 38, wherein the controller is further programmed to:

calculate a nitrogen partial pressure of the anode gas in accordance with a duration of the closed state of the purge valve;

determine a temperature of the fuel cell stack;

calculate a water vapor partial pressure of the anode gas on the basis of the temperature of the fuel cell stack;

calculate a hydrogen partial pressure of the anode gas by subtracting the nitrogen partial pressure and the water vapor partial pressure from an anode gas pressure; and

calculate the first energy loss on the basis of variation in the hydrogen partial pressure.

40. The anode effluent control device as defined in Claim 39, wherein the fuel cell stack comprises an anode which is exposed to the anode gas, a cathode, and an electrolyte membrane disposed between the anode and the cathode, the device further comprises an air supply device which supplies air to the cathode, and the controller is further programmed to calculate the nitrogen partial pressure of the anode gas on the basis of an amount of nitrogen

in the anode gas which increases as nitrogen in the air permeates the electrolyte membrane from the cathode so as to reach the anode.

41. The anode effluent control device as defined in Claim 39, wherein the device further comprises an anode gas passage which supplies the anode gas to the fuel cell stack, a hydrogen supply device which supplies hydrogen to the anode gas passage, a catalyst which oxidizes carbon monoxide in the anode effluent in the return passage, and an air supply device which supplies air for oxidizing the carbon monoxide to the return passage, and the controller is further programmed to calculate an accumulated amount of the carbon monoxide in the anode gas that was contained in the hydrogen supplied to the anode gas passage from the hydrogen supply device, compare the accumulated amount to a predetermined value, and supply air to the return passage from the air supply device when the accumulated amount is larger than the predetermined value.

42. The anode effluent control device as defined in Claim 41, wherein the controller is further programmed to prevent the air supply device from supplying air to the return passage when the purge valve is open.

43. The anode effluent control device as defined in Claim 41, wherein the device further comprises a pump for pressurizing the anode effluent in the return passage so as to introduce the anode effluent into the anode gas passage, and the controller is further programmed to reduce the rotation speed of the pump when air is supplied to the return passage from the air supply device.

44. The anode effluent control device as defined in Claim 41, wherein the controller is further programmed to calculate a partial pressure of carbon dioxide that is mixed into the anode gas as a result of a carbon monoxide oxidation operation performed by the catalyst, correct the nitrogen partial pressure of the anode gas on the basis of an amount of air supplied to the return passage, and calculate the hydrogen partial pressure by subtracting the water vapor partial pressure, the carbon dioxide partial pressure, and a corrected nitrogen partial pressure from the anode gas pressure.

45. The anode effluent control device as defined in Claim 41, wherein the device further comprises a recording device which pre-records a carbon monoxide content of the hydrogen that is supplied by the hydrogen supply device, and the controller is further programmed to calculate the accumulated amount of carbon monoxide in the anode gas on the basis of the carbon monoxide content recorded in the recording device.

46. The anode effluent control device as defined in Claim 39, wherein the controller is further programmed to calculate the nitrogen partial pressure of the anode gas as a value which increases as a duration of the closed state of the purge valve lengthens.

47. The anode effluent control device as defined in Claim 39, wherein the controller is further programmed to calculate the water vapor partial pressure of the anode gas as a value which increases as a temperature of the fuel cell stack rises.

48. The anode effluent control device as defined in Claim 37, wherein the controller is further programmed to calculate the second energy loss as a value which decreases in accordance with a duration of the closed state of the purge valve.

49. An anode effluent control device for a fuel cell stack which performs power generation using anode gas having hydrogen as a main component, the anode gas being discharged from the fuel cell stack as anode effluent following a power generation reaction, the device comprising:

- a return passage which re-circulates the anode effluent into the anode gas;

- a purge valve which discharges the anode effluent in the return passage to the outside of the passage;

- means for calculating a first energy loss caused by an increase in a non-hydrogen component in the anode gas while the purge valve is closed;

- means for calculating a second energy loss which corresponds to an amount of hydrogen lost from the anode gas when the purge valve is opened;

means for maintaining the purge valve in a closed state when the second energy loss is larger than the first energy loss; and
means for opening the purge valve when the second energy loss equals or falls below the first energy loss.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.